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mere heat evolved is not a true measure of the driving force of a chemical reaction, chemistry has felt an ever-growing need of accurate determinations of that which is the true measure, the free energy. A knowledge of this quantity permits the theoretical chemist to predict the direction in which a reaction will proceed or the state of equilibrium to which it will arrive, and enables the technical chemist to calculate the possible yield in a given manufacture, or the amount of work obtainable from a given process.

The present volume is by far the most important contribution towards this end which has as yet been made. It is a book written to technical chemists by an acknowledged master of technical chemistry, but it will doubtless find a larger audience among the uncommercial chemists; especially in this country where a broad knowledge of thermodynamics is not yet regarded as indispensable in the training of the chemical engineer.

The first three chapters deal with the theorems of thermodynamics and the development of the general free energy equation. In the fourth and fifth chapters comes the exhaustive discussion of the conditions of equilibrium in such important reactions as the water-gas process, the Deacon process and the formation from the elements of water, carbon dioxide, ammonia and the halogen acids. The sixth chapter critically summarizes all the existing data on the specific heat of gases, which must be known if we are to calculate the free energy at one temperature from that at another. The last chapter treats in detail the experimental methods which have been employed in the study of gaseous equilibria.

After a single perusal of the book the reader may not appreciate the infinite pains, or the critical acumen amounting nearly to inspiration, with which the author has extracted the truth from a great mass of uncertain and frequently contradictory experimental material. His success in this task has been demonstrated several times since the appearance of the German edition by new experimental investigations which have fully corroborated his conclusions.

The English edition, an excellent translation, contains additional matter in the form of three appendices. The first reviews the new and sensational method proposed by Nernst for the calculation of chemical equilibrium from thermal data. The second gives in detail the results of experiments carried on in the laboratories of Nernst and the author on the free energy of formation of carbon dioxide and water, of experiments by Lewis on the electromotive force of the oxygen-hydrogen cell, and of others by Lewis and Falkenstein on the Deacon process. The third appendix contains a miscellany of short notes dealing chiefly with the reaction velocity in gaseous systems.

To all who are interested in making chemistry an exact science, and who are not unwilling to read a book requiring a little thought and study, this work is heartily commended.

GILBERT N. LEWIS

Handbook of Flower Pollination. By DR. PAUL KNUTH; translated by J. R. AINSWORTH DAVIS. Vol. 2. Oxford, Clarendon Press. 1908.

For many years Hermann Müller's "Fertilization of Flowers by Insects," which had been translated into English, was the standard reference-book on all subjects connected with the relation of flowers to their insect-visitors. It was, however, getting very much out-of-date; so Dr. Paul Knuth, taking it as a basis, undertook the preparation of a new work, intended to include all the information available up to the date of publication. The new "Handbuch der Blütenbiologie" could not be included, like Müller's work, in a single volume, so it was divided into several sections. The first of these consisted of a general introduction; then came an account of the observations made in Europe; and finally, those from other parts of the world were to be given. Knuth did not live to see the last section published, but it was brought to a satisfactory completion in 1905 under the editorship of Dr. Ernst Loew.

There was naturally a demand for an English translation of the "Handbuch," and this

arduous task was undertaken by Professor J. R. Ainsworth Davis, of the University College of Wales. The first volume of the translation appeared in 1906; the second has just been published. The first volume differs from the original German, in that it contains the bibliography up to January 1, 1904. The second has been translated without substantial alterations, except that it is much more clearly printed, with fewer abbreviations. No attempt has been made to bring it up to date. The third volume, now in press, will finish the account of the European observations; and the fourth will be prepared next autumn or winter. The last part of Knuth's work, dealing with the "aussereuropäischen" observations, was naturally the most incomplete (pathetically so for many parts of the world!); and hence Professor Ainsworth Davis, in spite of the great increase of work involved, has arranged to incorporate all new information available up to the date of going to press. This will make the final volume almost a new book, and as such it will be invaluable to all students of flower pollination. American students should be careful to forward to Professor Davis any papers they may have written bearing upon the subject, and also any manuscript data they are able to furnish. Those who have the German edition will be able to note the omission of important data, and will have a chance this summer to make many observations which can be incorporated.¹

The second volume, the immediate subject of this notice, is of great value to American workers. In the first place, most of the European plants described are of American genera, and not a few of the species are circumpolar; in the second, there are many observations on purely American forms, made in European botanical gardens. So closely, indeed, are the European and American data related, that we can not help greatly regretting that they were not combined in a single series. The separation of the European and American sections will doubtless result in many workers procur-

¹ Professor Ainsworth Davis has just been appointed principal of the Royal Agricultural College, Cirencester, and should be addressed there after September 1.

ing only the one or the other, according to their place of residence. This will have the most unfortunate results; for example, American observers may work on particular genera, ignorant of the illuminating results obtained in Europe; or Europeans may take the records from botanical gardens as fairly representative for American genera, overlooking the very different data obtainable where these plants grow wild.

In the present state of the science, it is unavoidable that a work on flower pollination should contain a large amount of undigested information. The precise meaning of the long lists of visitors can not always be determined; and no doubt any author who should try to dispense with these lists, and state the results of research in general terms, would fall into many errors. There are, of course, many important and suggestive generalizations in the book; but every worker will be glad that he is supplied with the actual data at the back of these, data which he can compare minutely with those accumulated by himself.

In a work compiled from so many different sources there will necessarily be some errors. Thus the map on p. 49 does not do justice to the distribution of the humble-bees. *Bombus* extends quite to the north of Greenland (*cf.* Peary) and in Asia reaches the Philippines (*B. mearnsi* Ashmead), Sumatra (*B. senex* Snellen and *B. sumatrensis* Ckll.) and Java (*B. rufipes* Lep.).

T. D. A. COCKERELL

SPECIAL ARTICLES

REVISION OF "THE NEW YORK SERIES."

THE writer submits the following rearrangement of a part of Clarke and Schuchert's classification of the New York Paleozoic, including changes based chiefly upon the recent work of Hartnagel and others:

Hartnagel's redetermination of the Oneida conglomerate as the equivalent of the topmost or true Medina sandstone, and his separation from the latter of the great thickness of barren shales constituting his "lower Medina" with the suggestion of a disconformity at their top,